

激光与光电子技术应用

瑞利多普勒激光雷达F-P标准具的设计与校准分析

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摘要: 为了精确观测平流层风场, 采用F-P标准具作为瑞利散射测风激光雷达多普勒频率检测的核心器件, 对F-P标准具多普勒频率检测原理进行了理论分析, 从分析最大设计高度时的测量误差着手, 优化选取标准具透过率曲线参量; 介绍了透过率曲线参量的校准过程和校准方法, 分析了导致透过率曲线的半峰全宽增大的原因、透过率曲线校准精度对速度灵敏度及系统探测误差的影响; 并通过实验对设计和校准结果进行了验证。结果表明, 由于透过率曲线的半峰全宽增大, 导致速度灵敏度下降了 $0.118\%/(m \cdot s^{-1})$; 40km高度处, 在测量信噪比大于10的条件下, 径向速度测量精度增大2m/s。

关键词: 激光技术 激光雷达 Fabry-Perot标准具 瑞利散射 多普勒频率

Design and calibration of the Fabry-Perot etalon in Rayleigh backscattering Doppler wind lidar

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Abstract: The Fabry-Perot etalon was the key component of a Rayleigh Doppler wind lidar. In order to accurately determine the Doppler shift proportional to the wind velocity, the principle of Rayleigh Doppler frequency measurement was deeply analyzed, and the optimum parameters of the etalon were determined after analyzing the detection error at the maximum height designed. The calibration method and idea were introduced in detail. The factors making the full width at half maximum(FWHM) of the transmission curves broadened were analyzed, the calibration accuracy of the transmission curve affecting the velocity sensitivity and the system measuring error was also analyzed in detail. The design and calibration were verified in experiments. The result indicated that the velocity sensitivity of etalon decreased $0.118\%/(m \cdot s^{-1})$ due to the broadened FWHM of transmission curves and with the signal-to-noise ratio no less than 10, the accuracy of the line-of-sight velocity increased 2m/s at 40km altitude height.

Keywords: laser technique lidar Fabry-Perot etalon Rayleigh backscattering Doppler frequency

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